



# LAND OF THE CURIOUS





”

Clean energy, water and air are life-giving resources for which we at LUT University seek new solutions with our expertise in technology and business.

We help society and businesses in their sustainable renewal. Our international community consists of 6500 members. Our campuses are in Lappeenranta and Lahti, Finland.


 NUCLEAR SCIENCE AND TECHNOLOGY SYMPOSIUM 2022 (SYP2022)

# SMR Experiments with the MOTEL Test Facility within the Euratom Project McSAFER

Joonas Telkkä

Project Researcher | LUT University

[joonas.telkka@lut.fi](mailto:joonas.telkka@lut.fi)

 SMR Experiments with the MOTEL Test Facility within the Euratom Project McSAFER

# CONTENTS

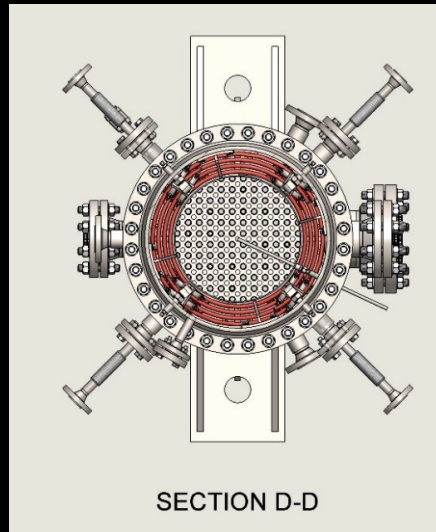
- » MOTEL test facility
- » Steam generator experiments within McSAFER
- » Results of the SG experiments
- » Conclusions



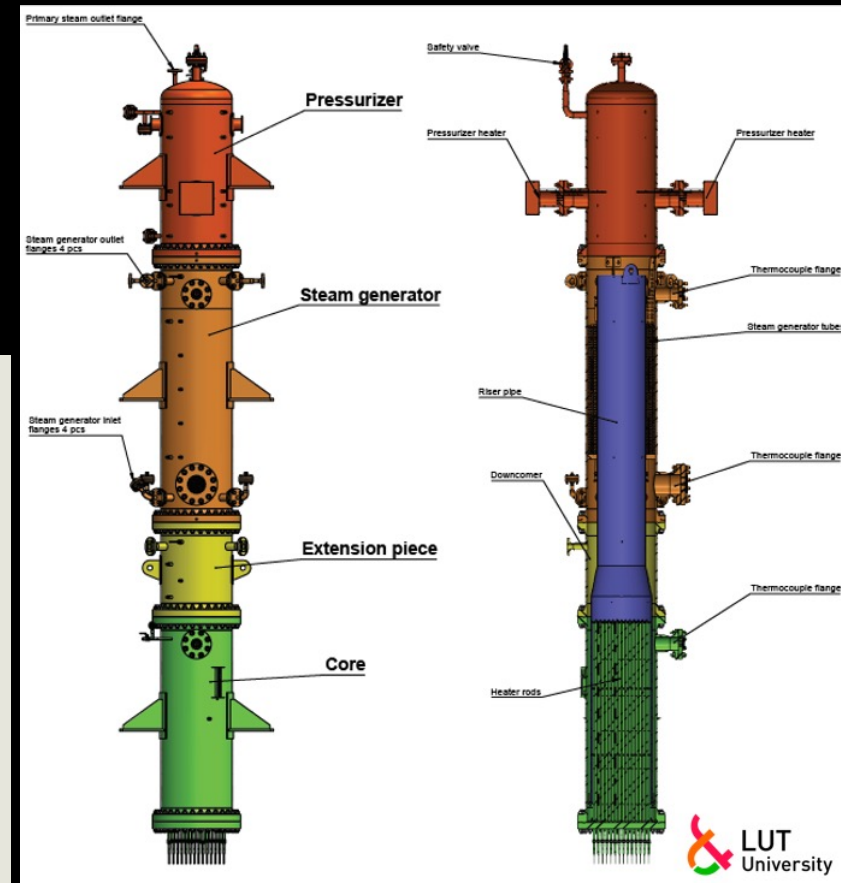
SMR Experiments with the MOTEL Test Facility within the Euratom Project McSAFER

# MOTEL TEST FACILITY

- » The MOTEL (MODular TEST Loop) facility models an SMR with resemblance to the NuScale SMR
- » Total height ~7.7 m, width ~0.7 m
- » Design pressure/temperature 40 bar/250 °C
- » Maximum heating power 990 kW
- » Generic NPP core with rectangular grid
- » Helical coil steam generator with 16 tubes
- » Primary flow driven passively by natural circulation
- » MOTEL was commissioned in 2020
- » Characterizing tests in 2021



Motel cross-section viewed from above



Modules comprising pressure vessel (left) and insights on the SMR design (right)

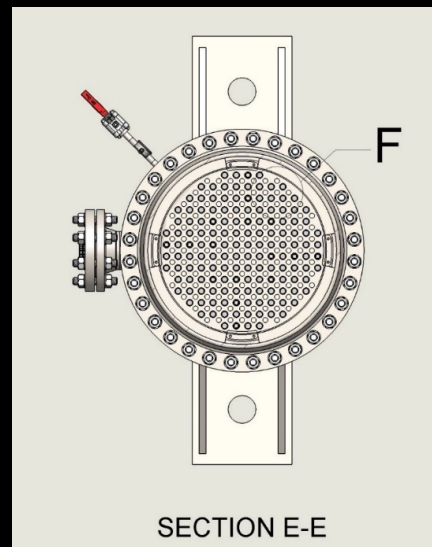
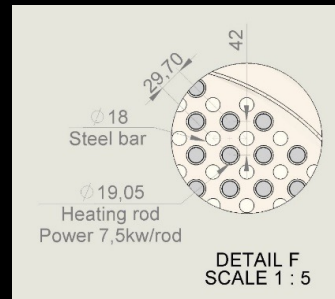


SMR Experiments with the MOTEL Test Facility within the Euratom Project McSAFER

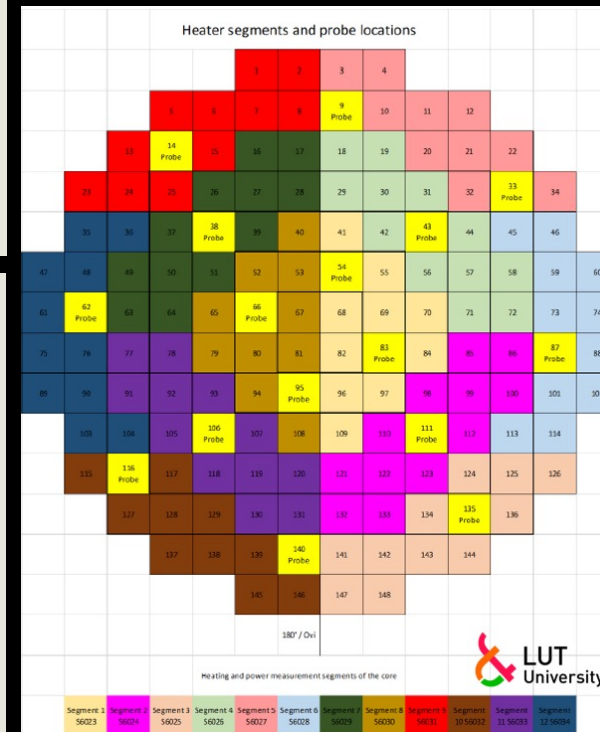
# MOTEL TEST FACILITY – CORE

MOTEL core does not represent any existing NPP core → a general representation of a core with rectangular pitch

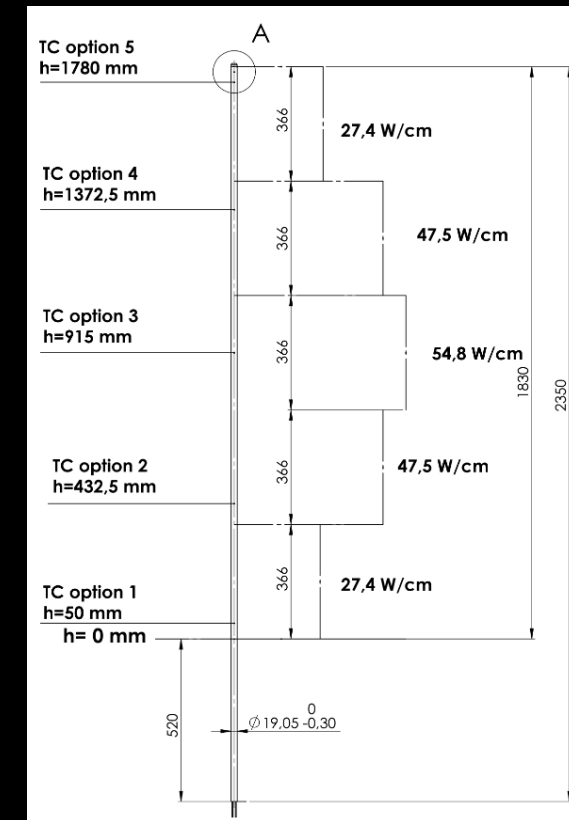
- » Maximum heating power 990 kW
- » Number of heating rods 132
  - Heated length 1830 mm
  - Diameter 19.05 mm
- » Number of instrumentation rods 16
- » Number of dummy rods 145
- » 12 radially adjustable power regions
- » 5-stepped axial power distribution



Core viewed from above



Radial adjustable power segments



Axial power distribution of a rod



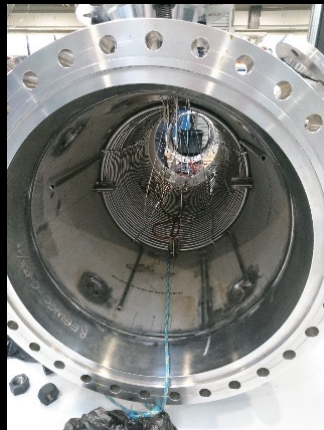
SMR Experiments with the MOTEL Test Facility within the Euratom Project McSAFER

# MOTEL TEST FACILITY – STEAM GENERATOR

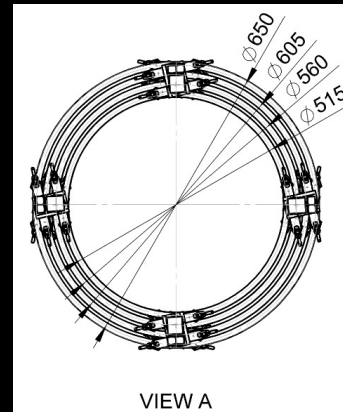
- » The steam generator is a helical coil type SG
- » 16 tubes in 4 groups
  - Tube diameter 15x1.2 mm
  - Helical diameters 515/560/605/650 mm
  - Helical tube lengths 20.0/21.7/23.4/25.1 m
- » Total heat transfer area 17 m<sup>2</sup>



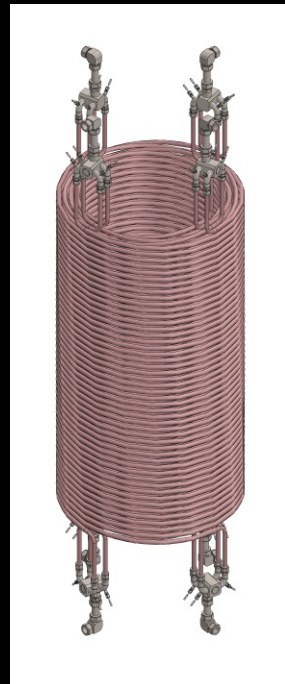
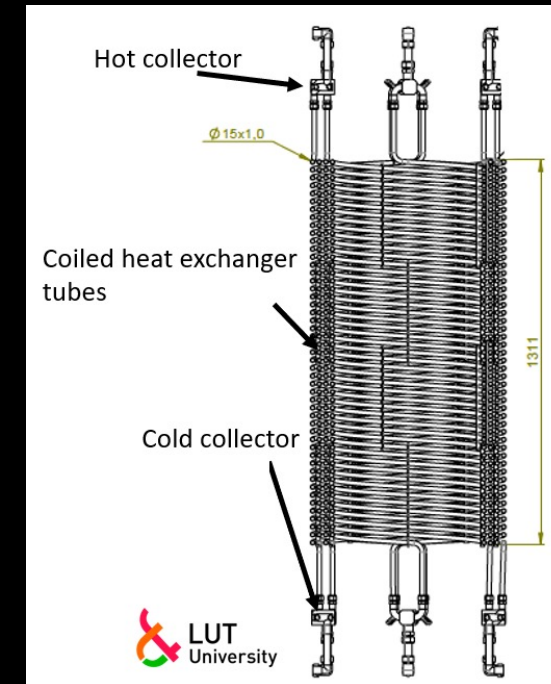
Cold collector



Assembling of SG tubes



Steam generator  
viewed from above



SMR Experiments with the MOTEL Test Facility within the Euratom Project McSAFER

# STEAM GENERATOR EXPERIMENTS WITHIN MCSAFER

Within McSAFER, two series of experiments were conducted:

1. Two tests studying behavior of the helical coil steam generator
2. Two tests studying core crossflows (not discussed in this presentation)

Steam generator experiments:

- » Steady states with different core heating powers were run
  - » Constant primary and secondary pressures → around 35 bar and 20 bar
  - » Particularly, temperature behavior of the steam generator (shell and tube sides) was studied
  - » Temperature distributions along the SG tubes were measured
1. In the first experiment, the power levels were 250 kW, 500 kW, 750 kW and 1 MW
  2. In the second experiment, the power levels were 75 kW, 100 kW, 125 kW and 150 kW



Thermocouple measurements in the MOTEL steam generator tubes

**Each SG tube has three temperature measurements + measurements near the cold and hot collectors**



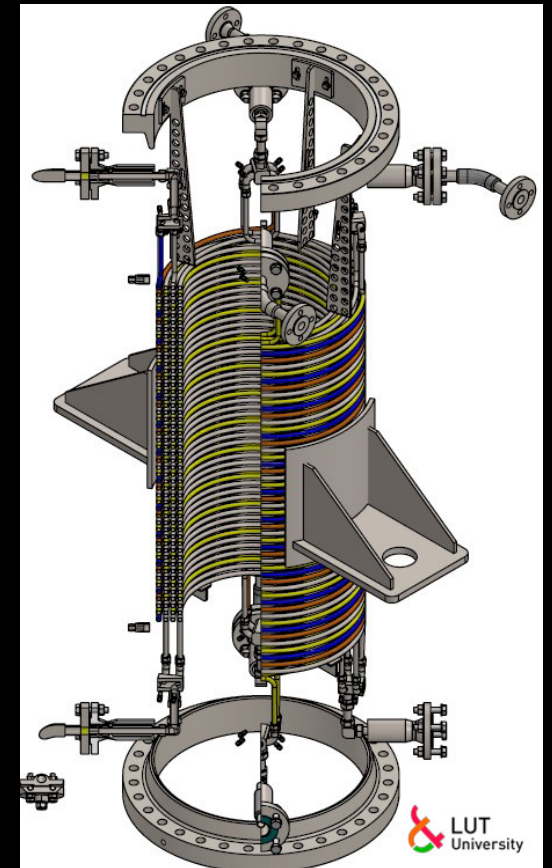
SMR Experiments with the MOTEL Test Facility within the Euratom Project McSAFER

# RESULTS OF THE SG EXPERIMENTS

## The first experiment:

"Steady state" steps with different core power levels, duration of each step 3600 s. Power levels 250 kW, 500 kW, 750 kW, 1000 kW → four (quasi-)steady states starting from 250 kW, steps upwards. The transients between the power levels measured also. Constant primary and secondary (SG) pressures → around 35 bar and 20 bar

- Clear increasing trend of SG temperatures during the test apart from the 250-kW power level
- Clear fluctuating behavior of temperatures and superheating, especially with higher power levels



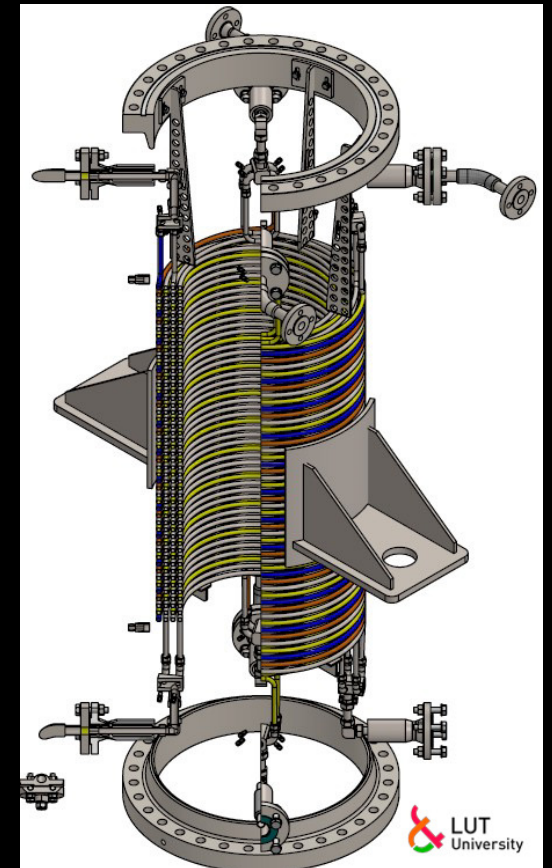
SMR Experiments with the MOTEL Test Facility within the Euratom Project McSAFER

# RESULTS OF THE SG EXPERIMENTS

## The second experiment:

The second experiment was like the first but with lower power levels: 75 kW, 100 kW, 125 kW and 150 kW

- » More stable temperature behavior (no increasing trend like in the first test)
- » Secondary side reached saturation in the bottom part of SG and remained mostly the same during the rest of the experiment → no significant superheating of steam
- » Slight fluctuation of the temperatures detected but not nearly as strong as in the first experiment with higher powers

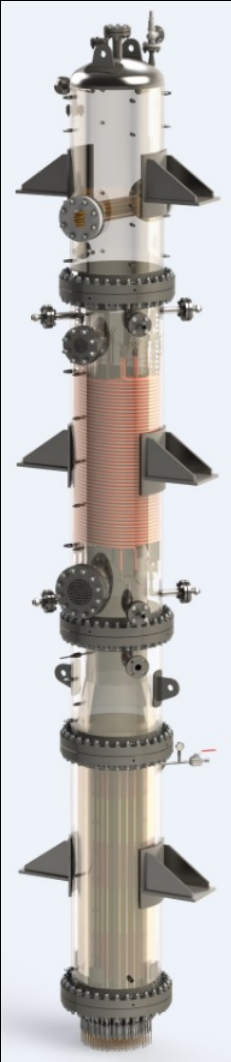




SMR Experiments with the MOTEL Test Facility within the Euratom Project McSAFER

# CONCLUSIONS

- » The new integral system thermal hydraulic test facility MOTEL was commissioned at LUT University in 2020
- » Two experiments studying the behavior and dynamics of a helical coil SG were conducted in 2021 within the EU- funded McSAFER project
- » The experiments provided first insight to the behavior of the facility and particularly the steam generator
- » Unstable superheating behavior at higher heating powers was observed
  - Further investigations to determine the operating parameter boundaries for stable operation
- » The experiments have already provided useful data regarding the system behavior and for the validation of system and CFD codes







# LAPPEENRANTA CAMPUS





